

Architecture in NanoSpace

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As the borderlines between Chemistry and key areas of Physics and Biology vanish, so multidisciplinary research is leading to the fascinating "new" overarching field of Nanoscience and Nanotechnology (N&N). Ingenious strategies for the creation of molecules with complex, exactly-specified, structures and as well as function are being developed – basically molecules that "do things" are now being created. Although N&N is not new at all it is the "*Frontier Chemistry of the 21st Century*". When the molecule C₆₀ Buckminsterfullerene and its elongated cousins the carbon nanotubes or Buckytubes were discovered, it suddenly became clear that our understanding of the factors governing the bottom-up assembly of atomic and molecular structures involving carbon and other atoms was quite naïve – especially with regard to the factors that govern dynamic construction at nanometer scale.

New experimental approaches which exploit the intrinsic way that small numbers of atoms cluster together have led to the production of novel nanostructured materials and a general refocusing of research interests on ways of controlling so-called "bottom-up self-assembly". These new approaches are leading to novel advanced materials exhibiting functional behaviour with novel applications. Fascinating fundamental insights into formation mechanisms have been revealed and nanoscale devices, which parallel devices in standard macroscopic engineered devices are now being created. On the horizon are possible applications ranging from civil engineering to advanced molecular electronics which promise to transform the socio-economics of everyday life. These fundamental advances suggest that supercomputers in our pockets (as well as our heads) and buildings which can withstand powerful hurricanes and earthquakes are possible. However if these breakthroughs are to be realised in practice, a paradigm shift in synthetic chemical techniques will be necessary. In fact we need to learn how to create really large molecules with very precisely defined structures at the atomic level. This presents one of the greatest technical challenges for chemists. It is also worth pondering implications of the fact that the C₆₀ molecule, which is almost exactly one nanometer (10⁻⁹m) in diameter, was discovered during an experiment aimed at understanding earlier astronomy results which had uncovered puzzling facts about the molecular constituents of dusty interstellar clouds which are up to 100 light years in size – indeed some 10²⁸ or a thousand million, million, million, million times larger than C₆₀! Yet another of countless examples of major scientific advances arriving from left field and a timely reminder of the dangers of neglecting fundamental science research and the serious limitations of strategically focused when it comes to development of truly paradigm-shifting scientific as well as technological breakthroughs.

The emergence of Internet as a powerful force, as exemplified by not only Google, Wikipedia and YouTube¹ (what I call the GooYouWiki World - GYWW) but also the Web 2.0 social networking phenomenon has been nothing short of sensational. This capacity to facilitate mass communication of various kinds efficiently, cheaply, and quickly across the globe at last offers the possibility we might be able to solve the endemic problem of science education not only for students but also the lay public. To this end I have started a Global Educational Outreach for Science Engineering and Technology (GEOSET) program at Florida State University (GEOSET). The websites www.geoset.info and www.chem.fsu.edu is streaming SET educational material for science teachers as well as researchers in academia and industry as well as students. Some outstanding scientific material created by students will be presented. GEOSET is a natural development from my earlier Vega Science Trust website (www.vega.org.uk) which streams more than 200 TV/Internet educational science programmes (75 shown on the BBC) to improve the general level science understanding.

¹ <http://www.youtube.com>